Project Summary

Competitive Inhibition of *E. coli* 0157:H7 and *Salmonella* spp. in Ground Beef Products

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Background
Highly publicized outbreaks of food-borne illness since 1993, primarily caused by bacteria such as E. coli O157:H7, Salmonella spp. and Listeria monocytogenes, elicited intense consumer concern about meat safety. In response, regulatory authorities, researchers and the beef industry initiated efforts to implement food safety management systems that would improve microbiological quality. The USDA Food Safety and Inspection Service (FSIS) began initiating new regulatory requirements during the mid-1990s. Packers were required to knife-trim carcasses to remove all visible contaminants, comply with written sanitation standard operating procedures (SSOP), implement Hazard Analysis Critical Control Point (HACCP) systems, and meet microbiological performance criteria and standards for E. coli and Salmonella as a means to verify HACCP effectiveness and pathogen reduction.

Researchers and beef packers/processors have addressed consumer food safety concerns by developing a variety of methods that are now implemented, or are being further developed, to reduce numbers of bacteria on beef and beef products and improve microbiological safety. These microbiological decontamination technologies include:

- Animal cleaning;
- Chemical dehairing at slaughter;
- Spot-cleaning of carcasses by knife-trimming or steam/hot water vacuuming; and
- Spraying/washing/rinsing of carcasses before evisceration and/or before chilling, with water, chemical solutions and/or steam or hot water.

Ground beef products are commonly implicated as sources for E. coli and Salmonella outbreaks. While many intervention technologies exist for beef carcasses, very few interventions exist that have been validated for ground beef products. Previous research has found that lactic acid bacteria (LAB) inhibit L. monocytogenes in ready-to-eat meat products. It was hypothesized that LAB, when added to ground beef, could inhibit the growth of both E. coli 0157:H7 and Salmonella spp. in ground beef stored at refrigeration temperatures.

Methodology
A total of 10 different ground beef samples were prepared (five for E. coli 0157:H7 and five for Salmonella spp.) and inoculated with pathogens. Frozen concentrated samples of four LAB cultures were prepared and combined into a “cocktail” mixture and thoroughly mixed into eight ground beef samples. These ground beef samples were vacuum packed and refrigerated (5°C) for 12 days. In addition, two control samples (one inoculated with E. coli 0157:H7 and one with Salmonella spp.) received no LAB treatment and were packaged, refrigerated and stored using the same protocol. Pathogen levels were sampled on days 4, 8 and 12.

Findings
**E. coli 0157:H7 Inoculated Samples**
After four days of storage at refrigeration temperatures, one of the LAB cultures (designated as M35) resulted in significantly lower levels of E. coli 0157:H7 compared to the control samples.
The effectiveness of the LAB cultures increased as storage time increased. After 8 and 12 days of storage, there were significantly lower levels of *E. coli* 0157:H7 in each of the LAB cultured samples compared to the control samples. The most effective LAB culture decreased *E. coli* 0157:H7 by more than 90 percent versus the control samples.

**Salmonella spp. Inoculated Samples**
LAB had a more inhibitory effect on the *Salmonella spp.* inoculated ground beef samples. After four days of storage at refrigeration temperatures, there were significantly lower levels of *Salmonella spp.* in three of the four LAB cultured samples compared to the control samples. The effectiveness of the LAB cultures increased as storage time increased. After eight days of storage, larger differences in *Salmonella spp.* populations between the LAB cultured samples and the control samples were found; and the difference were even greater after 12 days. Only one LAB cultured sample did not significantly inhibit the growth of *Salmonella spp.* versus the control samples. The most effective LAB culture decreased *Salmonella spp.* by more than 99.9 percent versus the control samples.

The findings of this study showed that adding lactic acid bacteria (LAB) to ground beef significantly reduce *E. coli* 0157:H7 and *Salmonella spp.* populations at refrigeration temperatures. This study is being continued in order to assess the extent to which adding a combined LAB cocktail containing all four cultures at a higher inoculation level to ground beef inhibits *E. coli* 0157:H7 and *Salmonella spp.* growth. Additionally, sensory evaluations of LAB-inoculated ground beef are planned in order at determine the feasibility of using LAB from a product quality perspective.

**Implications**
Ground beef contaminated with *E. coli* and *salmonella* is implicated in many outbreaks of food-borne illness. Interventions at multiple beef processing stages are now in use and the addition of lactic acid bacteria (LAB) to ground beef may be an effective strategy to control food-borne pathogens in ground beef.

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